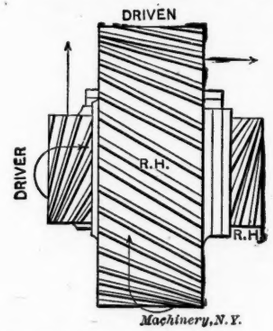
Shafts at Right Angles, Ratio Unequal, C. D. Approximate



Sum of spiral angles of gear and pinion must equal 90 degrees.

Given or assumed:

1. Position of gear having right- or left-hand spiral depending on rotation and direction in which thrust is to be received.
2. C_a = approximate center distance.
3. P_n = normal pitch (pitch of cutter).
4. R = ratio of gear to pinion.
5. n = number of teeth in pinion $= \dfrac{1.41\ C_a\ P_n}{R+1}$ for 45 degrees $= \dfrac{2\ C_a\ P_n \cos\alpha \cos\beta}{R\cos\beta + \cos\alpha}$ for any angle.
6. N = number of teeth in gear $= n\ R$.
7. α = angle of spiral on gear.
8. β = angle of spiral on pinion.

To find:

a. When spiral angles are 45 degrees.

1. D = pitch diameter of gear $= \dfrac{N}{0.70711\ P_n}$
2. d = pitch diameter of pinion $= \dfrac{n}{0.70711\ P_n}$
3. O = outside diameter of gear $= D + \dfrac{2}{P_n}$
4. o = outside diameter of pinion $= d + \dfrac{2}{P_n}$
5. T = number of cutter (gear) $= \dfrac{N}{0.353}$
6. t = number of cutter (pinion) $= \dfrac{n}{0.353}$
7. L = lead of spiral on gear $= \pi D$.
8. l = lead of spiral on pinion $= \pi d$.
9. C = center distance (exact) $= \dfrac{D+d}{2}$

b. When spiral angles are other than 45 degrees.

1. $D = \dfrac{N}{P_n \cos\alpha}$
2. $d = \dfrac{n}{P_n \cos\beta}$
3. $T = \dfrac{N}{\cos^3\alpha}$
4. $t = \dfrac{n}{\cos^3\beta}$
5. $L = \pi D \cot\alpha$
6. $l = \pi d \cot\beta$

Example

Given or assumed:

1. Fig. 10 (thrust diagram). 2. $C_a = 3.2$ inches. 3. $P_n = 10$. 4. $R = 1.5$.

5. $n = \dfrac{1.41\ C_a\ P_n}{R+1} = \dfrac{1.41 \times 3.2 \times 10}{1.5+1}$ = say 18 teeth. 6. $N = n\ R = 18 \times 1.5 = 27$ teeth.

7. $\alpha = 45$ degrees. 8. $\beta = 45$ degrees.

To find:

1. $D = \dfrac{N}{0.70711\ P_n} = \dfrac{27}{0.70711 \times 10} = 3.818$ ins. 2. $d = \dfrac{n}{0.70711\ P_n} = \dfrac{18}{0.70711 \times 10} = 2.545$ ins.
3. $O = D + \dfrac{2}{P_n} = 3.818 + \dfrac{2}{10} = 4.018$ inches. 4. $o = d + \dfrac{2}{P_n} = 2.545 + \dfrac{2}{10} = 2.745$ inches.
5. $T = \dfrac{N}{0.353} = \dfrac{27}{0.353} = 76.5$, say 76 teeth. 6. $t = \dfrac{n}{0.353} = \dfrac{18}{0.353} = 51$ teeth.
7. $L = \pi D = 3.1416 \times 3.818 = 12$ inches. 8. $l = \pi d = 3.1416 \times 2.545 = 8$ inches.
9. $C = \dfrac{D+d}{2} = \dfrac{3.818 + 2.545}{2} = 3.182$ inches.

Contributed by James H. Carver

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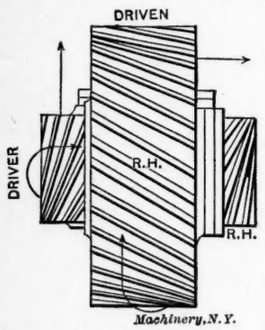
Shafts at Right Angles, Ratios Unequal, Center Distance Exact



Gears have same direction of spiral. The sum of spiral angles of both gears will equal 90 degrees.

Given or assumed:

1. Position of gear having right- or left-hand spiral depending on rotation and direction in which thrust is to be received. (See thrust diagram.)
2. P_n = normal pitch (pitch of cutter).
3. R = ratio of number of teeth in large gear to number of teeth in small gear.
4. α_a = approximate spiral angle of large gear.
5. C = exact center distance.

To find:

1. n = number of teeth in small gear nearest $\dfrac{2\ C\ P_n \sin\alpha_a}{1 + R\tan\alpha_a}$
2. N = number of teeth in large gear $= R\,n$.
3. α = exact spiral angle of large gear, found by trial from $R\sec\alpha + \operatorname{cosec}\alpha = \dfrac{2\ C\ P_n}{n}$
4. β = exact spiral angle of small gear $= 90° - \alpha$.
5. D = pitch diameter of large gear $= \dfrac{N}{P_n \cos\alpha}$
6. d = pitch diameter of small gear $= \dfrac{n}{P_n \cos\beta}$
7. O = outside diameter large gear $= D + \dfrac{2}{P_n}$
8. o = outside diameter small gear $= d + \dfrac{2}{P_n}$
9. T = number of teeth marked on cutter for large gear $= \dfrac{N}{\cos^3\alpha}$
10. t = number of teeth marked on cutter for small gear $= \dfrac{n}{\cos^3\beta}$
11. L = lead of spiral on large gear $= \pi D \cot\alpha$.
12. l = lead of spiral on small gear $= \pi d \cot\beta$.

Example

Given or assumed:

1. Fig. 10 (thrust diagram). 2. $P_n = 8$. 3. $R = 3$. 4. $\alpha_a = 45$ degrees. 5. $C = 10$ inches.

To find:

1. $n = \dfrac{2\ C\ P_n \sin\alpha_a}{1 + R\tan\alpha_a} = \dfrac{2 \times 10 \times 8 \times 0.70711}{1+3} = 28.25$, say 28 teeth.
2. $N = R\,n = 3 \times 28 = 84$ teeth.
3. $R\sec\alpha + \operatorname{cosec}\alpha = \dfrac{2\ C\ P_n}{n} = \dfrac{2 \times 10 \times 8}{28} = 5.714$. $\therefore \alpha = 46° 6'$.
4. $\beta = 90° - \alpha = 90° - 46° 6' = 43° 54'$. 5. $D = \dfrac{N}{P_n \cos\alpha} = \dfrac{84}{8 \times 0.6934} = 15.143$ inches.
6. $d = \dfrac{n}{P_n \cos\beta} = \dfrac{28}{8 \times 0.72055} = 4.857$ ins. 7. $O = D + \dfrac{2}{P_n} = 15.143 + 0.25 = 15.393$ ins.
8. $o = d + \dfrac{2}{P_n} = 4.857 + 0.25 = 5.107$ inches. 9. $T = \dfrac{N}{\cos^3\alpha} = \dfrac{84}{0.333}$, say 252 teeth.
10. $t = \dfrac{n}{\cos^3\beta} = \dfrac{28}{0.374}$ = say 75 teeth.
11. $L = \pi D \cot\alpha = 3.1416 \times 15.143 \times 0.96232 = 45.78$ inches.
12. $l = \pi d \cot\beta = 3.1416 \times 4.857 \times 1.0392 = 15.857$ inches.

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